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Academic and social success in adolescents with previous febrile seizures

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ABSTRACT

Objective: To study academic achievement and social success in adolescents with febrile seizures (FS) before their 5th birthday.
Subjects and methods: A random birth cohort (n = 900) was prospectively followed from early pregnancy and examined at ages 12 and 18 years to study the relationships between FS and school achievement (three most important school marks), behavior and social competence (Achenbach Childhood Behavior Checklist, Youth Self-Report), life management (Antonovsky Sense of Coherence Scale) and social participation.
Results: No significant differences could be detected between children with vs. without FS or between boys vs. girls in academic achievement, behavior, social competence, life management, or social participation, either at age 12 or 18 years, except for more somatic complaints of girls at age 18. Of adolescents with previous FS, 29% had not participated in the maturity examination, 20% had participated but failed and 51% had passed, comparing 35%, 18% and 47%, respectively, of those without FS (p = 0.6676).
Conclusions: Our study confirms the findings of the previous population studies reporting similar academic and social success between children with and without febrile seizures before the 5th birthday. Reassurance of the parents about a favorable future may ameliorate their worries at this frightening event in their child's life.

1. Introduction

Only a few population-based studies exist and they show no significant effect of FS on intelligence or academic performance.[1–5] In an extensive 7-year follow-up study of approx. 54000 children,[1] no significant difference was found between children with vs. without FS in intelligence. At the age of 16 years, children with prior FS performed both academically and behaviorally as well as their peers.[4] In another population survey[5] of school-aged children, no significant association with FS could be found in academic performance or behavior. Assessment of cognitive abilities and school achievement after 12-year follow-up was normal in Danish children and did not differ between the two groups randomly allocated to intermittent prophylaxis (diazepam at fever) or no prophylaxis (diazepam at seizures) whether FS were simple or complicated.[3] In a comparative study between children with FS vs. healthy controls, no significant neurophychological differences were found in short-term follow-up, but children with prolonged FS showed a significantly lower non-verbal intelligence as compared with controls or children who had simple FS.[6]

Few data exist on social competence associated with previous FS. Hutt et al.[7] compared school-aged children who had FS before 4 years of age with their peers and found no significant difference in social adjustment. Working-class children, however, tended to be socially less well adjusted than their middle-class controls. There are no recent long-term studies on cognitition and behavior following FS. The most parents whose child has had febrile seizures are often very concerned about the child's future health and risk for mental retardation, paralysis, physical disability and learning dysfunction.[8] Our purpose was to study academic achievement and social success of a population-based cohort of children with febrile seizures before their 5th birthday in a prospective long-term follow-up setting.

2. Subjects and methods

2.1. Subject recruitment

A birth cohort sample was collected from a Finnish south-western province (total population 713,000) in 1986 using a

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stratified, randomized cluster sampling procedure. After standardization of the study area for socio-economic class, 11 of all 35 health authority areas as clusters, were randomly drawn for the study. The study population characteristics did not significantly differ from those in the province as a whole.[9] The sampling area included 67 maternity care clinics and 72 well-infant clinics.

The initial cases were nulliparous women who were expecting their first child and had visited a public maternity health care clinic on their own initiative for the first time between January 1st, 1986 to December 31st, 1986. All of these women spoke Finnish or Swedish. In Finland, more than 99% of expectant mothers attend these clinics where they are followed throughout their pregnancy.[10] Staff doctors and nurses at these clinics were specifically educated about the study and approached all the eligible women. Ninety-one percent ($n = 1443$) of those eligible agreed to participate and the total sample comprised 1294 newborns who all were mentally normal (IQ > 70). At age 18 years, the check-up covered 787 (78%) of 1003 families who had been followed up to the age of five years. The study design has previously been reported in detail.[9,11,12]

2.2. Dropout analysis

Table 1 shows the flow chart and number of dropouts during the different stages of the follow-up. The only data available about 139 of 1582 mothers who declined to enter the study indicated that their occupations did not differ from those who gave informed consent ($p = 0.27$). Of 1443 families who gave informed consent, 149 further families failed to participate. They included 72 families with spontaneous or induced abortion, 17 with multiple births or stillbirth, 8 with relocation abroad or in Finland, 9 with unacceptably or defectively completed forms, and 43 who refused to participate. Thus, 1294 children were included in the follow-up study. One child died at age 9 years.

At age of 12, 900 (70%) and at age 18, 787 (61%) of 1294 children participated the follow-up examination. Dropout analysis was made between the 787 participants and 507 dropouts. A selection bias might be assumed between the participants and dropouts considering the low retention rate during 18-year follow-up. Dropouts might be expected to be poorer learners than the participants. Therefore, we focussed on academic achievement of the participants and nonparticipants. In Finland, one of the best available measure of academic achievement is passing the maturity examination, usually at age 18 years. Passing the Finnish national written matriculation examination is the basis of starting university studies. The requirement level of the matriculation examination is comparable with that of the US matriculation examination plus one year of university.[13] The comparison did not show any significant difference ($p = 0.6676$) between the participants and dropouts with regard to not participating to, participating to, or participating and passing the examination (29%, 20%, 51% respective 35%, 18%, 47%; $p = 0.6676$) which argues against selection bias.

Table 1
Subject participation (N) in the follow-up examinations.

Time point of check-up	Eligible	Participants	Dropouts
10th week of pregnancy	1582	1443	139
28th week of pregnancy	1443	1294	149
Delivery	1294	1247	47
3 months	1247	1216	31
9 months	1216	1111	105
18 months	1111	1025	86
3 years	1025	887	138
5 years	1025	1003	22
7 years	1003	881	22
12 years	1003	908	95
16 years	908	857	51
18 years	857	787	70

2.3. Methods

In the course of prospective follow up examinations (Table 1), data were collected about medical and social aspects of health including FS and recurrent unprovoked seizures by means of posted questionnaires for mothers and fathers and for children 12 years or older. In addition, notes made by the designated physician and nurse in the well-infant clinic were available up to school age. Additional data were obtained, throughout the study, from diaries completed online by the parents and data from children's well-baby clinics.

Febrile seizures were defined as ones diagnosed contemporarily by doctor.[11] Children who had one or more FS until their 5th birthday (later referred to as previous FS) were considered as cases. FS at age less than 4 weeks were excluded. Febrile status epilepticus was defined as seizure lasting 30 min or more. Seizures were considered recurrent if they were two or more with a 24 h or longer interval.

Academic achievement was assessed at age 12 and 18 years by the class teacher who rated the school marks (scale from 4 to 10) of native language, best foreign language, and mathematics, determined by the national Board of Education of Finland as the most important and illustrative subjects (www.oph.fi). In Finland, the native language is Finnish in approx. 94%, Swedish in about 5%, and another language (mostly English, German, French, or Spanish) in the remaining 1%. At age 18 years, language-based achievement was assessed using the data from the national Finnish written matriculation examination (National Central Statistics Bureau files 2004). The registry covers all the students who have participated the matriculation examination. This examination is designed measure knowledge, skills and maturity required by the curriculum for the upper secondary school.

Behavior and social competence was assessed using the Achenbach Child Behavior Checklist (CBCL) for 12–18-year-olds completed by the parents and the Youth Self-Report (YSR) by the children.[14] The CBCL consists of two major scales: a social competence scale (including the areas of social activities, social tasks and school competence) and behavioral problem scale scored as continuous variables. The lower scores reflect fewer problems.

Life management was measured by the Antonovsky sense of coherence scale.[15,16] Sense of coherence is characterized as an individual's readiness to deal with every day life stress. In a previous study, based on the same data as the present study,[16] the sense of coherence was shown to be reasonably stable from 15 to 18 years of age. Furthermore, life management was assessed by participation in social life including teams, clubs, bands, choirs, associations and similar activities. Social relations considered relationships with peers, siblings, parents, teachers and other adults.

2.4. Statistical analysis

For pairwise comparisons, chi square test and Fisher exact test (two-tail) when appropriate, t-test, were applied. For multivariate analysis, stepwise logistic regression analysis was used.

The study was approved by the Joint Ethics Review Committee of the University of Turku Medical School and the University of Turku Central Hospital.

3. Results

3.1. Background factors

In our prospective population study, 58 (6.4%) of 900 children had one or more previous febrile seizures (FS). Compared with families whose child had not had any previous FS, mothers with FS

Table 2
Marks (scale 4–10) of children with and without febrile seizures in three most important school subjects at ages 12 (CI = confidence interval).

	Subjects at age 12								
	Mother tongue			First foreign language			Mathematics		
	All	FS	Non-FS	All	FS	Non-FS	All	FS	Non-FS
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Marks									
4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
5	3 (0.4)	0 (0.0)	3 (0.4)	8 (1.0)	1 (1.8)	7 (0.9)	6 (0.7)	0 (0.0)	6 (0.8)
6	20 (2.5)	2 (3.6)	18 (2.4)	45 (5.6)	4 (7.3)	41 (5.5)	37 (4.6)	4 (7.1)	33 (4.4)
7	117 (14.6)	12 (21.8)	105 (14.1)	135 (17.0)	16 (29.1)	119 (16.1)	103 (12.8)	9 (16.1)	94 (12.5)
8	313 (39.0)	22 (40.0)	291 (39.0)	247 (31.0)	17 (30.9)	230 (31.0)	235 (29.1)	24 (42.9)	211 (28.1)
9	308 (38.4)	18 (32.7)	290 (38.8)	280 (35.2)	13 (23.6)	267 (36.0)	341 (42.3)	16 (28.6)	325 (43.3)
10	41 (5.1)	1 (1.8)	40 (5.3)	81 (10.2)	4 (7.3)	77 (10.4)	85 (10.5)	3 (5.4)	82 (10.9)
All	802 (100.0)	55 (100.0)	747 (100.0)	796 (100.0)	55 (100.0)	741 (100.0)	807 (100.0)	56 (100.0)	751 (100.0)
Mean (SD) and differences of mean (95% CI)									
All	8.28 (0.89)	8.07 (0.88)	8.29 (0.89)	8.24 (1.09)	7.89 (1.13)	8.27 (1.08)	8.39 (1.03)	8.09 (0.98)	8.41 (1.04)
		−0.22 (−0.46, 0.02)			−0.38 (−0.67, −0.08)			−0.32 (−0.60, −0.04)	
		$p = 0.0742$			$p = 0.0131$			$p = 00233$	
Boys	7.97 (0.90)	7.83 (0.98)	7.98 (0.89)	8.10 (1.09)	7.83 (1.09)	8.12 (1.09)	8.37 (1.06)	8.13 (0.80)	8.39 (1.07)
		−0.16 (−0.54, 0.22)			−0.29 (−0.74, 0.16)			−0.26 (−0.70, 0.18)	
		$p = 0.4180$			$p = 0.2099$			$p = 0.2434$	
Girls	8.54 (0.79)	8.25 (0.76)	8.57 (0.79)	8.36 (1.08)	7.94 (1.18)	8.40 (1.06)	8.41 (1.02)	8.06 (1.11)	8.44 (1.00)
		−0.32 (−0.60, −0.03)			−0.46 (−0.85, −0.07)			−0.38 (−0.74, −0.01)	
		$p = 0.0299$			$p = 0.0216$			$p = 0.0430$	

children had diarrhea during the last semester more often (13% vs. 5%, $p = 0.0150$), and fathers had more frequent headaches (39% vs. 17%, $p < 0.0001$), and the child with previous FS was more likely to have failed to be toilet trained for urine at age 18 months (12% vs. 4%, $p = 0.0180$). The following factors were not significantly associated with the occurrence of FS: parental basic or vocational education, civil status or socioeconomic status, previous spontaneous abortions, maternal health status and life style intoxications (smoking, use of alcohol or illicit drugs) during pregnancy, mode of delivery, Apgar scores, and postnatal treatment on neonatal or pediatric ward, frequency of feeding with breast milk, child's day care type, father's role in child care, or overall motor and cognitive development (gross motor, fine motor, visuomotor performance and visual and spatial perception).

Up to the age of 18 years, 7 (0.88%)/792 children had life-time unprovoked seizures diagnosed by physician. In Fisher's exact test, the risk of the incidence of recurrent unprovoked seizures was not significantly higher in children with previous FS than in children without FS (2.04% vs. 0.81%, $p = 0.3650$).

3.2. Academic achievement

Table 2 shows the school marks (scale 4–10) in the three most important subjects at the age 12 years. No children received the mark of 4 and very few had the mark of 5 in any subject. All the three marks were non-significantly different in boys and girls. Similarly, at age 18 (Table 3), no significant differences were found between genders. Need for special education did not significantly

Table 3
Marks (scale 4–10) of children with and without febrile seizures in three most important school subjects at ages 18 (CI = confidence interval).

	Subjects at age 18								
	Mother tongue			First foreign language			Mathematics		
	All	FS	Non-FS	All	FS	Non-FS	All	FS	Non-FS
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Marks									
4	0 (0.0)	0 (0.0)	0 (0.0)	5 (0.7)	1 (2.3)	4 (0.6)	11 (1.5)	0 (0.0)	11 (1.6)
5	14 (1.9)	1 (2.3)	13 (1.9)	31 (4.3)	0 (0.0)	31 (4.6)	52 (7.2)	3 (6.8)	49 (7.2)
6	43 (6.0)	2 (4.5)	41 (6.1)	75 (10.4)	3 (7.0)	72 (10.7)	110 (15.3)	7 (15.9)	103 (15.2)
7	124 (17.2)	7 (15.9)	117 (17.3)	85 (11.8)	11 (25.6)	74 (11.0)	145 (20.1)	11 (25.0)	134 (19.8)
8	276 (38.3)	21 (47.7)	255 (37.7)	175 (24.4)	13 (30.2)	162 (34.5)	176 (24.4)	13 (29.5)	163 (24.1)
9	217 (30.1)	10 (22.7)	207 (30.6)	227 (31.6)	12 (27.9)	215 (31.8)	125 (17.3)	5 (11.4)	120 (17.7)
10	47 (6.5)	3 (6.8)	44 (6.5)	120 (16.7)	3 (7.0)	117 (17.3)	102 (14.1)	5 (11.4)	97 (14.3)
All	721 (100.0)	44 (100.0)	677 (100.0)	718 (100.0)	43 (100.0)	675 (100.0)	721 (100.0)	44 (100.0)	677 (100.0)
Mean (SD) and differences of mean (95% CI)									
All	8.08 (1.07)	8.05 (1.03)	8.08 (1.07)	8.17 (1.41)	7.93 (1.22)	8.18 (1.42)	7.67 (1.53)	7.57 (139)	7.68 (1.54)
		−0.04 (−0.36, 0.29)			−0.25 (−0.69, 0.18)			−0.11 (−0.58, 0.36)	
		$p = 0.8159$			$p = 0.2599$			$p = 0.6404$	
Boys	7.60 (1.07)	7.82 (0.81)	7.59 (1.08)	7.88 (1.43)	7.65 (1.32)	7.89 (1.44)	7.57 (1.48)	7.41 (1.42)	7.58 (1.49)
		0.23 (−0.29, 0.76)			−0.24 (−0.94, 0.46)			−0.16 (−0.89, 0.56)	
		$p = 0.3789$			$p = 0.4966$			$p = 0.6564$	
Girls	8.44 (0.92)	8.19 (1.14)	8.46 (0.90)	8.38 (1.36)	8.12 (1.14)	8.40 (1.38)	7.75 (1.56)	7.67 (1.39)	7.76 (1.57)
		−0.27 (−0.63, 0.08)			−0.28 (−0.83, 0.26)			−0.09 (−0.70, 0.52)	
		$p = 0.1339$			$p = 0.3013$			$p = 0.7697$	

Table 4
Behavioral problems until age 18 according to the Child Behavior Checklist in children with vs. without febrile seizures before 5th birthday (p-values from t-tests; CI = confidence interval).

	All	Girls	Boys
Checklist			
Total	0.1915	0.1117	0.6780
Externalising problems	0.1468	0.1211	0.5421
Delinquent behavior	0.2240	0.1929	0.9554
Aggressive behavior	0.2956	0.1276	0.3480
Internalising problems	0.0346	0.0318	0.7935
Differences of mean	1.56	2.29	
(95%CI)	(0.11, −3.00)	(0.20, −4.38)	
Withdrawn behavior	0.2238	0.2088	0.9315
Somatic complaints	0.0139	0.0059	0.2748
Difference of mean	0.76	0.96	
(95%CI)	(0.16, −1.34)	(0.09, −1.82)	
Anxious/depressive	0.3522	0.2213	0.6250
Social problems	0.6781	0.9690	0.4538
Thought problems	0.5712	0.5636	0.7440
Attention problems	0.9598	0.5147	0.2565

differ between children with or without previous FS (data not shown).

At the age of 18 years, kappa coefficients for FS children's self-estimates about school achievements were 0.64 for mother tongue, 0.24 for best foreign language, and 0.68 for mathematics in children with previous FS. The corresponding figures for children without previous FS were 0.59, 0.74 and 0.75.

Of the adolescents with previous FS at age 18 years, 29% had not participated in the maturity examination, 20% had participated but failed to pass and 51% had passed, comparing 35%, 18% and 47%, respectively, of those without previous FS. The difference was not significant ($p = 0.6676$).

3.3. Behavior and social competence

The Child Behavior Checklist showed no significant changes between children with or without previous FS, or between boys and girls with previous FS. At age 18 years with previous FS, but not boys, had internalizing problems ($p = 0.0318$) in the form of somatic complaints ($p = 0.0059$), while all other symptoms were non-significantly different (Table 4). Youth Self-Report revealed no significant associations between boys and girls with previous FS, or overall association between children with and without previous FS. Social competence, assessed by the CBCL and the YSR, did not significantly differ between the FS and non-FS groups, either in boys or girls.

3.4. Life management

Life management, measured by the Antonovsky sense of coherence test, is closely associated with social competence, but the test did not reveal any significant differences between children with and without previous FS ($p = 0.6$), or between boys and girls. There was no significant difference in the frequency of membership on teams, clubs and similar organizations, number of close friends and frequency of meeting them; overall interaction with siblings, other children, parents or other adults; being bullied or bullying at school; or other conflicts with social environment.

4. Discussion

Two most prominent previous population-based studies[2,4] reported no differences at age 7 and 10 years, respectively, in academic progress between children with or without previous febrile seizures. Similarly, our study revealed no significant differences in academic achievement either at age 12 or 18 years in boys or girls. Furthermore, except for significantly more frequent somatic complaints of girls at age 18, no differences were found in social dimensions, including behavior, social competence, life management or social participation. The results of our study were based on stratified, randomized cluster sampling, particularly designed, during prospective long-term follow-up, to detect developmental abnormalities and long-term illnesses. Data were collected from early pregnancy, often using semi-structured questionnaires and well-known, translated and back-translated and validated scales. The data were from parents, children's welfare clinic doctors and nurses, school teachers and since the age of 12 years, the study subjects themselves. The prospective follow-up period of 18 years and 13 post-FS years appear to be long enough to measure the effects of FS. Comparison of children with and without previous FS was possible in a nested case–control study setting, which minimized the problems of comparison. Our findings at age 18 were further confirmed by the results of the national written maturity examination at age 18 years (National Central Statistics Bureau files 2004), which again detected no significant differences in either participation to or passing the examination of adolescents with or without previous FS. The life-time prevalence of 0.88% of the present study is not unexpected. While unprovoked seizures occurred ostensibly 2.5 times as often in children with previous FS as among children without previous FS, the difference is not significant, probably due to a too small sample size for that assessment. Consequently, our study lacks power to show whether or not FS are a risk factor for following unprovoked seizures.

Three school subjects, mother tongue, best foreign language and mathematics, are strongly emphasized in the Finnish 9-year compulsory school system as a measure of upper school academic achievements (www.oph.fi). The marks assigned by the teacher appeared justified because they were reasonably consistent with the parents and children's self-assessment. Class teachers can be considered good evaluators of their pupils' educational achievement, but also behavior and mental health.[17]

Our results are in agreement with a previous extensive population-based study.[2] Another population study reported that significantly more children with FS in the first year of life had received special education than children without FS.[4] In our study, the need for special education was similar in the two groups. A Danish twin study[18] found problems in mathematics in children with previous FS. A British study[4] reported no significant differences in the scores for mathematics between children with or without FS. In line with our results, no significant associations with socioeconomic factors were found in a British population study.[19] In consonance with our findings, neither of the two large population studies[2,4] reported any gender differences in the occurrence of learning disorders.

Behavior disorder in our adolescents after previous FS was limited to internalizing problems in girls including anxiety and depression at age 18. Similarly, Verity et al.[4] reported children with FS to be significantly more anxious, impulsive and excitable than controls although they did not report on gender differences. Hutt et al.[7] found no significant association between social class and behavior of children with a history of FS except in a subgroup of working class children where there was a tendency to poorer social adjustment. The same study noted that boys received higher Assistance scores indicating greater dependency in boys than girls on the Self-Administered Dependency Questionnaire.[7] While a recent review by Sarkadi et al.[20] emphasized the importance of fathers' involvement for children's developmental outcome, our study did not support the statement. Life management, measured by the sense of coherence, was not significantly different in children with or without a history of FS. We have previously shown

that the sense of coherence is reasonably stable in adolescence.[16] Therefore, no substantial change in the sense of coherence was to be expected.

The strengths of the present study include its prospective character, population-based methodology, long-term follow-up, and broadspectrum approach to the causes and consequences. Weaknesses might include the problem of dropouts, so common in long-term follow-up studies. The incidence of FS of 6.9% (95% confidence interval 6.0–8.3) before 5th birthday[21] of the whole cohort did not significantly differ from that of 6.4% (5.0–8.3) of the present sample which argues for the absence of selection bias. Passing the written matriculation examination is considered as a robust indicator of academic achievement in the Finnish society. The examination is passed only when the national examination board has approved all of the tests which justify the participation to the examination, has accepted the final written examination and signed the certificate. Similar success of both the participants and dropouts on this examination again refers to the absence of selection bias.

5. Conclusion

Our study confirms the findings of the previous population studies which report similar academic and social success between children with and without febrile seizures before the 5th birthday. Reassurance of the parents about a favorable future may ameliorate their worries at this frightening event in their child's life.

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